
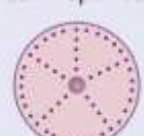






Table II-6-3. Metazoans: Worms\*

Phylum	Roundworms	Flat worms (Platyhelminthes)	
Class	Nematodes**	Trematodes	Cestodes
Common name	Roundworms	Flukes	Tapeworms
Genera	<u>Necator</u> <u>Enterobius</u> <u>Wuchereria/Brugia</u> <u>Ascaris</u> and <u>Ancylostoma</u> <u>Toxocara</u> , <u>Trichuris</u> & <u>Trichinella</u> <u>Onchocerca</u> <u>Dracunculus</u> <u>Eye worm (Loa loa)</u> <u>Strongyloides</u>	<u>Fasciola</u> <u>Fasciolopsis</u> <u>Paragonimus</u> <u>Clonorchis</u> <u>Schistosoma</u>	<u>Diphyllobothrium</u> <u>Hymenolepis</u> <u>Taenia</u> <u>Echinococcus</u>

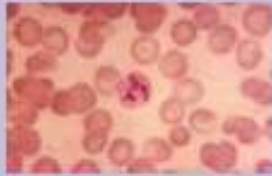
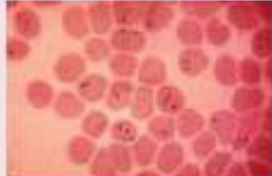
Table II-6-4. Protozoan Parasites

Species	Disease/Organs Most Affected	Form/Transmission	Diagnosis	Treatment
<i>Entamoeba histolytica</i>	<p><b>Amebiasis:</b> dysentery</p> <p><b>Inverted flask-shaped</b> lesions in large intestine with extension to peritoneum and liver, lungs, brain, heart</p> <p><b>Blood and pus</b> in stools</p> <p><b>Liver abscesses</b></p>	<p>Cysts</p> <p>Fecal-oral transmission: water, fresh fruits, and vegetables</p>	<p>Trophozoites or cysts in stool:</p>  <p>Serology: Nuclei have sharp central karyosome and fine chromatin "spokes."</p> 	Metronidazole followed by paromomycin
<i>Giardia lamblia</i>	<p>Giardiasis:</p> <p>Ventral sucking disk attaches to lining of duodenal wall, causing a <b>fatty, foul-smelling diarrhea</b> (diarrhea → <b>malabsorption</b> duodenum, jejunum)</p>	<p>Cysts</p> <p>Fecal (human, beaver, muskrat, etc.), oral transmission (water, food, day care, oral-anal sex)</p>	<p>Pear-shaped trophozoites with bilobed nuclei or cysts in stool, or fecal antigen test</p>   <p>"Falling leaf" motility</p>	Metronidazole
<i>Cryptosporidium</i> sp. <i>C. parvum</i>	<p>Cryptosporidiosis:</p> <p>transient diarrhea in healthy hosts; severe, immunocompromised hosts</p>	<p>Cysts</p> <p>Undercooked meat, water; not killed by chlorination</p>	<p><b>Acid-fast oocysts in stool:</b> Biopsy shows dots (cysts) in intestinal glands</p> 	Nothing is 100% effective; nitazoxanide, paromomycin, or azithromycin is drug of choice

**Table II-6-4. Protozoan Parasites (Cont'd)**

Species	Disease/Organs Most Affected	Form/Transmission	Diagnosis	Treatment
<i>Cystoisospora belli</i>	Transient diarrhea in AIDS patients; diarrhea mimics giardiasis malabsorption syndrome	Oocysts Ingestion Fecal-oral	<b>Acid-fast, elliptical oocysts in stool</b> ; contain 2 sporocysts each with 4 sporozoites	TMP-SMX or pyrimethamine/sulfadiazine
<i>Cyclospora cayentanensis</i>	Self-limited diarrhea in immunocompetent; prolonged, severe <b>diarrhea in AIDS</b> patients	Oocysts, water, contaminated imported food	Fecal; <b>acid-fast, spherical oocysts</b> ; contain 2 sporocysts each with 2 sporozoites; UV fluorescence	TMP-SMX
<i>Microsporidia</i> (6 genera)	Microsporidiosis: persistent, debilitating <b>diarrhea in AIDS</b> patients; other spp → neurologic, hepatitis, disseminated	Spores ingested	<b>Gram (+), acid-fast spores</b> in stool or biopsy material	None proven to be effective
<i>Trichomonas vaginalis</i> (urogenital)	Trichomoniasis: often asymptomatic or <b>frothy vaginal discharge</b> Colpitis macularis	Trophozoites <b>Sexual</b>	Motile trophozoites in methylene blue wet mount; <b>corkscrew motility</b> 	<b>Metronidazole</b>

**Table II-6-6. *Plasmodium* Species**

Species	Important Features	Blood Smears	Liver Stages	Treatment**
<i>Plasmodium vivax</i>	48-hour fever spikes	Enlarged host cells; ameboid trophozoites 	Persistent <b>hypnozoites</b> <b>Relapse*</b>	Chloroquine, then <b>primaquine</b>
<i>Plasmodium ovale</i> (2 substrains)	48-hour fever spikes	Oval, jagged, infected RBCs	Persistent hypnozoites Relapse	Chloroquine, then primaquine
<i>Plasmodium malariae</i>	72-hour fever spikes; recrudescence*	Bar and band forms; rosette schizonts	No persistent stage*; recrudescence*	Chloroquine (no radical cure necessary)
<i>Plasmodium falciparum</i>	Irregular fever spikes; causes <b>cerebral malaria</b>	<b>Multiple ring forms</b> <b>crescent-shaped gametes</b> 	No persistent stage*; recrudescence	<ul style="list-style-type: none"> <li>• Chloroquine for susceptible, non-severe cases</li> <li>• Atovaquone-proguanil, artemether-lumefantrine, mefloquine for resistant, non-severe cases</li> <li>• Quinine/quinidine for severe cases</li> </ul>
<i>Plasmodium knowlesi</i>	24-hour fever spikes	Similar to <i>P. malariae</i>	No persistent stage	Chloroquine



**Table II-6-7. Hemoflagellates**

Species	Disease	Vector/Form/ Transmission	Reservoirs	Diagnosis	Treatment
<i>Trypanosoma cruzi</i> *	<ul style="list-style-type: none"> <li>• <b>Acute: Chagas disease</b> (American trypanosomiasis); Mexico, South/Central America; swelling around eye (<b>Romaña sign</b>); myocarditis and meningoencephalitis</li> <li>• <b>Chronic:</b> dilated cardiomyopathy, megacolon, achalasia</li> </ul>	<b>Reduviid bug (kissing or cone bug;</b> genus <i>Triatoma</i> ) passes trypomastigote (flagellated form) <b>in feces</b> ; scratching implants in mucosa	<ul style="list-style-type: none"> <li>• Cats, dogs, armadillos, opossums</li> <li>• Poverty housing</li> </ul>	Blood films, <b>trypomastigotes</b>	Benznidazole or nifurtimox
<i>Trypanosoma brucei gambiense</i> <i>Trypanosoma b. rhodesiense</i>	<b>African sleeping sickness</b> (African trypanosomiasis) <b>Antigenic variation</b>	Trypomastigote in saliva of <b>tsetse fly</b> contaminates bite	Humans, some wild animals	<ul style="list-style-type: none"> <li>• Trypomastigotes in blood films, CSF</li> <li>• High immunoglobulin levels in CSF</li> </ul>	Acute: suramin Chronic: melarsoprol
<i>Leishmania donovani</i> ** complex	<b>Visceral leishmaniasis</b>	<b>Sandfly</b> bite	Urban: humans Rural: rodents and wild animals	<b>Amastigotes in macrophages</b> in bone marrow, liver, spleen	Stibogluconate sodium (from CDC)
<i>Leishmania</i> (About 15 different species)	Cutaneous leishmaniasis (Oriental sore, etc.)	<b>Sandfly</b> bite	Urban: humans Rural: rodents and wild animals	<b>Amastigotes in macrophages</b> in cutaneous lesions	Stibogluconate sodium
<i>Leishmania braziliensis</i> complex	Mucocutaneous leishmaniasis	<b>Sandfly</b> bite	Urban: humans Rural: rodents and wild animals	Same	Stibogluconate sodium

\* *Trypanosoma cruzi* is a zoonotic parasite. *Trypanosoma brucei* is a zoonotic parasite. *Trypanosoma brucei gambiense* is a zoonotic parasite. *Trypanosoma brucei rhodesiense* is a zoonotic parasite. *Leishmania donovani* is a zoonotic parasite. *Leishmania* is a zoonotic parasite. *Leishmania braziliensis* is a zoonotic parasite.




<i>Toxoplasma gondii</i>	<b>Cat (essential definitive host);</b> many other animals (intermediate host) Mode: raw meat in U.S. (#1 is pork) and contact with cat feces	Serology High IgM or rising IgM acute infection		<b>Pyrimethamine + sulfadiazine</b>
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## Nematodes

The nematodes are the roundworms. They cause a variety of diseases (e.g., pinworms, whipworms, hookworms, trichinosis, threadworms, filariasis).


- Round unsegmented bodies
- Transmitted by:
  - Ingestion of eggs (*Enterobius*, *Ascaris*, *Trichuris*) or meat containing larvae (*Trichinella*)
  - Direct invasion of skin by larval forms (*Necator*, *Ancylostoma*, *Strongyloides*)
  - Infection involving insects transmitting the larvae with bites (*Wuchereria*, *Loa loa*, *Mansonella*, *Onchocerca*)

Table II-6-9. Round Worms (Nematodes) Transmitted by Eggs

Species	Disease/Organs Most Affected	Form/Transmission	Diagnosis		Treatment
<i>Enterobius vermicularis</i> Most frequent helminth parasite in U.S.	<b>Pinworm</b> Large intestine, nocturnal perianal itching	<b>Eggs/person to person</b> <b>Autoinfection</b>	<ul style="list-style-type: none"> <li>• Cellophane tape prep of perianal area</li> <li>• Ova have flattened side with larvae inside</li> </ul>		Pyrantel, <b>albendazole</b> Treat entire family
<i>Trichuris trichiura</i>	<b>Whipworm</b> Cecum, appendicitis, and rectal prolapse	<b>Eggs</b> Ingested	<b>Barrel-shaped eggs with bipolar plugs</b> in stools		Albendazole
<i>Ascaris lumbricoides</i> Most common helminth worldwide Largest roundworm	<b>Ascariasis</b> Ingest egg → larva migrate thru lungs (cough) and mature in small intestine; may obstruct intestine or bile duct	<b>Eggs</b> Ingested	<b>Bile stained, knobby eggs</b> Adults <b>6–12"</b> roundworms		Supportive therapy during pneumonitis; surgery for ectopic migrations; albendazole
<i>Toxocara canis</i> or <i>cati</i> (dog/cat ascarids)	<b>Visceral larva migrans</b> Larvae wander aimlessly until they die, cause inflammation	<b>Eggs</b> Ingested/from handling puppies or from eating dirt in yard (pica)	Clinical findings and serology		Albendazole; self-limiting in most cases



**Table II-6-10. Roundworms (Nematodes) Transmitted By Larvae**


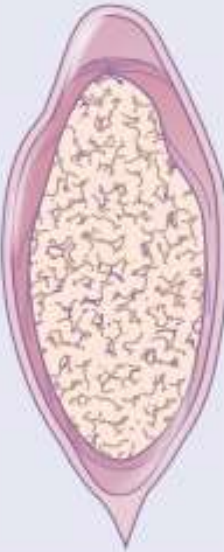
Species	Disease/Organs	Form/Transmission	Diagnosis	Treatment
<i>Necator americanus</i> New World hookworm	<b>Hookworm</b> infection Lung migration → pneumonitis bloodsucking → anemia	Filariform larva <b>penetrates intact skin of bare feet</b>	Fecal larvae (up to 13 mm) and ova: oval, transparent with 2–8 cell-stage visible inside Occult blood fecal may be present 	<b>Albendazole</b> and iron therapy
<i>Ancylostoma braziliense</i> <i>Ancylostoma caninum</i> (dog and cat hookworms)	<b>Cutaneous Larva Migrans</b> /intense skin itching	Filariform larva penetrates intact skin but cannot mature in humans	Usually a presumptive diagnosis; exposure	Thiabendazole Topical corticosteroids
<i>Strongyloides stercoralis</i>	<b>Threadworm</b> strongyloidiasis: Early: pneumonitis, abdominal pain, diarrhea Later: malabsorption, ulcers, bloody stools	Filariform larva <b>penetrates intact skin</b> <b>Autoinfection</b> leads to indefinite infections unless treated	Larvae in stool, serology	Ivermectin
<i>Trichinella spiralis</i>	Trichinosis: larvae encyst in muscle → pain	<b>Viable encysted larvae in meat</b> are consumed; wild game meat (bear meat)	Muscle biopsy; clinical findings: <b>fever, myalgia, splinter hemorrhages, eosinophilia</b>	Steroids for severe symptoms and albendazole

**Table II-6-11. Filarial Nematodes**

Species	Disease	Transmission/Vector	Diagnosis	Treatment
<i>Wuchereria bancrofti</i> ; <i>Brugia malayi</i>	Elephantiasis; tropical pulmonary eosinophilia	Mosquito	Microfilariae in blood, eosinophilia	Surgery, ivermectin and diethylcarbamazine
<i>Loa loa</i> (African eye worm)	Pruritus, Calabar swellings	<i>Chrysops</i> Mango flies, deer flies	Microfilariae in blood, eosinophilia	Surgical removal of worms; diethylcarbamazine or ivermectin
<i>Onchocerca volvulus</i>	River blindness, itchy "leopard" rash	Blackflies	Skin snips from Calabar swellings	Surgical removal of worms; diethylcarbamazine or ivermectin
<i>Dracunculus medinensis</i> (guinea worm, fiery serpent)	Creeping eruptions, ulcerations, rash	Drinking water with infected copepods	Increased IgE; worm eruption from skin	Slow, cautious worm removal with stick



**Table II-6-12. Trematode (Fluke) Diseases**

Organism	Common Name	Reservoir Host	Acquisition	Progression in Humans	Important Ova	Treatment
<i>S. mansoni</i> <i>Schistosoma japonicum</i>	<b>Intestinal schistosomiasis</b>	Cats, dogs, cattle, etc.	Contact with water; <b>skin penetration</b>	Skin penetration (itching) → mature in veins of mesentery → eggs cause granulomas in liver (liver enlargement in chronic cases)  Clay pipe-stem fibrosis of portal vein		Praziquantel
<i>Schistosoma haematobium</i>	<b>Vesicular schistosomiasis</b>	Primates	Contact with water; <b>skin penetration</b>	Skin penetration (itching) → mature in bladder veins; chronic infection has high association with <b>bladder carcinoma in Egypt and Africa</b>		Praziquantel

**Table II-6-13. Gastrointestinal Cestodes (Tapeworms)**

Cestode*	Form/Transmission	Humans Are	Disease/Organ Involvement/ Symptoms (Sx)	Diagnosis	Treatment
<i>Taenia saginata</i> (beef tapeworm) IH: cattle DH: humans	Rare beef containing the <b>cysticerci</b> is ingested	DH*	<b>Intestinal tapeworm</b> /small intestine Sx: asymptomatic or vague abdominal pains	<b>Proglottids</b> or <b>eggs</b> in feces	Praziquantel
<i>Taenia solium</i> (pork tapeworm) IH: swine; Rarely: humans DH: humans; developing and Slavic countries	Water, vegetation, food contaminated with <b>eggs</b> <b>Autoinfection</b>	IH*	<b>Cysticercosis</b> /eggs → larva develop in brain, eye, heart, lung, etc. Adult-onset epilepsy (seizures)	Biopsy	Praziquantel; surgery in some sites
	Rare/raw pork containing the <b>cysticerci</b> is ingested by humans	DH	<b>Intestinal tapeworm</b> Sx: as for <i>Taenia saginata</i>	<b>Proglottids</b> or <b>eggs</b> in feces	Praziquantel
<i>Diphyllobothrium latum</i> (fish tapeworm) IH (2): crustaceans → fish; rare: humans DH: humans/mammals; cool lake regions	Drinking pond water w/ → copepods (crustaceans) carrying the <b>larval</b> forms or frog/snake poultices	IH	<b>Sparganosis</b> /larvae penetrate intestinal wall and encyst	Biopsy	Praziquantel
	Rare, raw pickled fish → containing a <b>sparganum</b>	DH	<b>Intestinal tapeworm</b> (up to 10 meters)/small intestine <b>megaloblastic anemia</b>	Proglottids or eggs in feces	Praziquantel
<i>Echinococcus granulosus</i> IH: herbivores; rare: humans DH: carnivores in sheep-raising areas	Ingestion of eggs	IH	<b>Hydatid cyst disease</b> /liver and lung where cysts containing brood capsules develop	Imaging; serology	Surgery; albendazole
<i>Echinococcus multilocularis</i> IH: rodents DH: canines and cats; northern areas	Ingestion of eggs	IH	<b>Alveolar hydatid cyst disease</b>	Imaging; serology	Surgical resection

\* Definitive host = adult tapeworm develops in; intermediate host = cysticerci or larvae develop in; cysticerci = encysted larvae found in intermediate host. Common name is in parentheses.

## CLASSIFICATION OF PARASITES

Medical parasitology is the study of the invertebrate animals and the diseases they cause. Parasites are classified as protozoans or metazoans.

**Table II-6-1. Protozoa versus Metazoa**

	Protozoa	Metazoa
<b>Complexity</b>	Single-celled	Multicellular
<b>Onset of clinical symptoms</b>	Days to weeks	Typically >1 month
<b>Diagnostic forms</b>	Cysts and trophozoites	Eggs
<b>Elevated immune levels</b>	Typically neutrophils	Eosinophils

The tables list the protozoan and metazoan classifications. The most important organisms in the United States are set in **boldface**.

**Table II-6-2. Protozoans**

Common Name	Amebae	Flagellates	Apicomplexa
<b>Important genera</b>	<i>Entamoeba</i> <i>Naegleria</i> <i>Acanthamoeba</i>	LUMINAL (GUT, UG) <i>Trichomonas</i> <i>Giardia</i> HEMOFLAGELLATES <i>Leishmania</i> <i>Trypanosoma</i>	BLOOD/TISSUE <i>Plasmodium</i> <i>Toxoplasma</i> <i>Babesia</i> INTESTINAL <i>Cryptosporidium</i> <i>Cystoisospora</i>